$\frac{1}{2}\beta°$, then the deflection from the new zero will be less still; so that there is no advantage in the use of the new zero unless the deflections exceed $\frac{1}{2}\beta°$.

If the angle $\beta°$ be made greater than 60° then the possible angular movement of the needle becomes still further increased; but inasmuch as any increase in the length of the tangent scale brings the divisions at the ends of the scale proportionally closer together, and makes them more difficult to read from, there would be no practical advantage in making the angle larger.

A marked advantage under certain conditions is found when the new zero has such a value that the deflection from a given current causes the needle to move up to the ordinary zero, that is to say, to the position where the needle becomes parallel to the coil; in this case the instrument becomes highly sensitive, and any increase in the strength of the current produces a very considerable change in the deflection.

VIII. "On Fluted Craterless Carbons for Arc Lighting." By Sir James N. Douglass. Communicated by Sir William Thomson, F.R.S. Received June 4, 1886.

[Plate 6.]

On the 8th December, 1858, at the South Foreland High Light-house, and with the direct current magneto machines of Holmes, the first important application of the electric arc light, as a rival to oil and gas for coast lighting, was carried out by the Trinity House, under the advice of Faraday. The carbons then used, and for several years afterwards, were sawn from the residuum carbon of gas retorts; they were square in section, $6\frac{1}{4} \times 6\frac{1}{4}$ mm., and the mean intensity of the arc, measured in the horizonal plane, was 670 candle units, being 17 candle units nearly per square millimetre of cross sectional area of the carbon. The crater formed at the point of the upper carbon of the "Holmes" lamp was so small that no appreciable loss of light was found to occur, and the arc proved to be very perfect in affording an exceptionally large vertical angle of radiant light for application with the optical apparatus as shown, one-third full size, in the sketch (Plate 6).

The most reliable and efficient machine that has yet been tried for lighthouse purposes is the large size alternate current magneto machine of De Meritens. The average results with these machines are as follows, viz.:—

	One machine.	Two machines supplying currents to one lamp.
E.M.F.	38 volts	48 volts.
Mean current	206 ampères	372 ampères.
Diameter of carbons (cylindrical)	35 mm.	50 mm.
„ crater in carbon	13 „	18 „
Mean intensity of arc measured in the horizontal plane (candle units	15,000	30,000
Light per square millimetre of carbon section (candle units)	12	12

It will be observed from this statement that the intensity of the arc in the horizontal plane per square millimetre of sectional area of carbon is about 35 per cent. less than it was with the small square carbons used by Holmes, although it might reasonably be expected that, with the improvements since effected in the manufacture of carbons, the efficiency of the old small carbons would at least be maintained. The relative efficiency of the large carbons used with the powerful currents now available appears to be due, 1st, to the loss of a large portion of the most intense part of the arc which is confined within the crater of each carbon; and, 2nd, to the fluctuations in the intensity of the arc caused by the current passing between various parts of the end of each carbon. For a new electric light installation, about to be made by the Trinity House at St. Catherine's Lighthouse, Isle of Wight, it is intended to utilise the large "De Meritens" machines that were used at the recent South Foreland experiments for determining the relative merits of electricity, gas, and oil as light-house illuminants. The electric light at St. Catherine's is intended to be "single flashing" at periods of 30 seconds. Each flash is to have a duration of $5\frac{1}{2}$ seconds, followed by an eclipse of $24\frac{1}{2}$ seconds. It is intended to use one "De Meritens" machine during clear weather, and two whenever the atmosphere is found to be so impaired for the transmission of light, that the flashes are not reaching their advertised range. The defect here arose, which is common to all electric flashing lights where a minimum and a maximum intensity are adopted, viz., that the duration of the flashes of minimum and maximum intensity would vary in the ratio of the difference in the diameters of the carbons employed with one and two machines respectively, which in this case should be 50 mm. and 35 mm., this mean difference amounting to $36\frac{1}{2}$ per cent. nearly.

It is evident that such a variation in the duration of flash would seriously impair the distinctive character of the signal. It occurred to me, however, that, if carbons of a fluted section were employed for the arc of minimum intensity whose extreme diameter corresponded

exactly with the diameter of the carbons used for the arc of maximum intensity, and of exactly half the sectional area of the latter, the defect referred to would be entirely obviated, and the flashes of maximum and minimum intensity would have exactly the same duration. As all carbons for electric arc lights are now made in moulds, I saw that such a form as shown in the accompanying full-size sketch (and model) would not involve any more difficulty in manufacture than if cylindrical, while there would be less liability of fracture occurring in the process of drying and baking. Other advantages to be obtained with fluted carbons are, 1st, a larger vertical angle of radiant light from the arc, and with a higher coefficient of intensity in consequence of the unobstructed radiance through the fluting at the points of each carbon; and, 2nd, a steadier light is obtained owing to the localising of the current at the central portion of each carbon.

The results of many experimental trials with fluted carbons 50 mm. diameter, as shown by the sketch and models submitted herewith, have entirely confirmed my expectations. It will be observed that no crater is formed, and the point of each carbon is all that can be desired for utilising fully the maximum light of the arc. My experiments have not been sufficient to determine accurately the additional intensity of light obtained from the arc of a pair of the fluted carbons as compared with that from the arc of a pair of cylindrical carbons, but I am of opinion that the gain with fluted carbons is not less than 10 per cent.

IX. "On some new Elements in Gadolinite and Samarskite, detected spectroscopically." By William Crookes, F.R.S., V.P.C.S. Received June 9, 1886.

The recent discovery by my distinguished friend M. de Boisbaudran* on the existence of a new element which he calls Dysprosium makes it unadvisable on my part, as a fellow investigator in spectroscopic research, to delay any longer the announcement of some of the results I have obtained during the fractionations of the samarskite and gadolinite earths.

I will first take the earths which give absorption-spectra when their solutions are examined by transmitted light. These occur chiefly at the higher end, beginning with didymium and proceeding, through samarium, holmium, &c., to erbium, which is one of the least basic. The earths which give phosphorescent spectra chiefly occur at the lower end, but each group overlaps the other; for instance yttria occurs above erbia.

* "Comptes rendus," vol. 102 (1886), p. 1003.